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HJ Kapadiya
Department of Plant Pathology, College of agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

AM Moradiya
Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh, Gujarat, India

Correspondence
HJ Kapadiya
Department of Plant Pathology, College of agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Management of groundnut disease through different organic practices and compared with chemical fungicide

HJ Kapadiya and AM Moradiya

Abstract
To know the effect of organic practices compared with chemical fungicide in management of groundnut disease under field condition. Ten treatments including a control were applied. Result revealed that seed treatment with Mancozeb 3g/kg seed followed by two sprays of Hexaconazole along with the application of recommended fertilizers (12.5N:25P) was very effectively reducing the collar rot (1.61%), stem rot (87%), tikka (19.55%), and rust (24.46%) with increasing pod (1896 kg/ha) and haulm (5484 kg/ha) yield and economical as compared to the application of FYM and biological control agents (organic farming). Application of FYM (7.5 tonne/ha) in place of NPK and *Trichoderma viride* as seed treatment @10 g/kg seed and in furrow @ 4.0 kg enriched in 250 kg FYM, *T. viride* foliar application @ 2.5 kg/ha 30 and 45 DAS was equally effective in increasing pod (1692 kg/ha) yield to realize higher income for the organic management of groundnut diseases. But, for the better management of foliar diseases, fungicide Hexaconazole is essential as it reduces the development of inoculums and further spreading of the diseases. Therefore, it is also concluded that although organic farming could reduce the soil borne diseases to some extent.

Keywords: Organic practices, chemical fungicide, bio control, seed treatment, organic amendment, foliar application

Introduction
Groundnut (*Arachis hypogaea* L.) is important food legume and oilseed crop. The total area of groundnut cultivation in India is 52.50 lakh ha which accounts for total production of 94.72 lakh tones with productivity of 1804 kg/ha. Among the major groundnut growing states, Gujarat is the most important one accounting for 18.42 lakh ha total area with 49.18 lakh tones production and productivity of 2670 kg/ha (Anonym, 2016) [3]. The productivity level of groundnut in India is far below the world average of 1400 kg/ha mainly because it is predominantly grown as a rain fed crop (80% of the total acreage) under various biotic and abiotic constraints that limit crop yield.

A large number of diseases attack to groundnut in India (Mayee, 1987; Mayee, and Datar. 1988; Ganesan and Sekar, 2004) [10, 12, 5, 6]. The majorities diseases are caused by fungi and several of them are yield reducers in certain regions and seasons (Mayee, 1995) [11]. This disease causes severe damage during any stage of crop growth, and yield losses over 25% have been reported by Mayee and Datar (1988) [12].

Thus other alternative disease management options were considered among which biological control appears promising. Although, now-a-days, many groundnut growing farmers are cultivating groundnut through organic practices like application of FYM or castor cake instead of chemical fertilizers. Application of biological control agents enriched with FYM is also a practice adopted by many farmers. Therefore, this experiment was formulated to evaluate the efficacy of application of organic amendment enriched with biological control agents, application of biological control agents and bio-product as foliar spray and furrow application in managing foliar diseases (tikka and rust) of groundnut.

Materials and Methods
A field trial was laid out at Main Oilseeds Research Station Junagadh Agricultural University, Junagadh during three year 2011-12 to 2013-14 in *kharif* seasons.

Groundnut variety GG-20 was sown in plot size 5.00 x 3.00m gross and 4.00x 1.80m net adopting a spacing of 60 x 10 cm. Ten treatment *viz.* T_1 seed treatment with *Trichoderma viride* @ 10 g/kg seed + furrow application of *T. viride* @ 4 kg enriched with FYM @ 250 kg/ha + foliar application of *T. viride* @ 5 g/lit water (2.5 kg/ha) at 30 and 45 days after sowing (DAS), T_2 seed treatment with *Pseudomonas fluorescens* @ 10 g/kg seed + furrow application of *P. fluorescens* @ 4 kg enriched with FYM @ 250 kg/ha + foliar application of *P. fluorescens* @ 5 g/lit (2.5 kg/ha) at 30 and 45 DAS, T_3 seed treatment with *T. viride* @ 10 g/kg seed + furrow application of *T. viride* @ 4 kg enriched with FYM @ 250 kg/ha + foliar application of neem seed kernel extract @ 5 % at 30 and 45 DAS, T_4 seed treatment with *P. fluorescens* @ 10 g/kg seed + furrow application of *P. fluorescens* @ 4 kg enriched with FYM @ 250 kg/ha + foliar application of neem seed kernel extract @ 5 % at 30 and 45 DAS, T_5 seed treatment with mixture of *T. viride* and *P. fluorescens* @ 10 g/kg seed + combined furrow application of *T. viride* and *P. fluorescens* @ 2 kg each enriched with FYM @ 250 kg/ha + foliar application of both @ 2 kg/ha at 30 and 45 DAS, T_6 seed treatment with mixture of *T. viride* and *P. fluorescens* @ 10 g/kg seed + combined furrow application of *T. viride* and *P. fluorescens* @ 2 kg each enriched with FYM @ 250 kg/ha + foliar application of neem seed kernel extract @ 5 % at 30 and 45 DAS, T_7 Recommended practices (seed treatment with Mancozeb @ 3 g/kg seed + foliar spray of Hexaconazole @ 1 ml/lit at 30 and 45 DAS along with recommended dose of NPK fertilizer), T_8 Seed treatment with *T. harzianum* @ 10 g/kg seed + furrow application of *T. harzianum* @ 4 kg enriched with FYM @ 250 kg/ha + foliar application of *T. harzianum* @ 5 g/lit (2.5 kg/ha) at 30 and 45 DAS, T_9 Seed treatment with *T. harzianum* @ 10 g/kg seed + furrow application of *T. harzianum* @ 4 kg enriched with FYM @ 250 kg/ha + foliar application of neem seed kernel extract @ 5 % at 30 and 45 DAS, T_{10} Control (without any application) imposed with three replication in completely randomize block design. Enriched the FYM made by mixing it with fresh talc based culture of *Trichoderma* before one week of sowing and maintained the moisture and applied in to furrow at the time of sowing. Moreover, FYM @7.5 tones/ha applied in all the treatments except T_7.

The collar rot at 30 DAS and stem rot at the time of harvesting, the number of healthy and infected plant were counted in each treatment and per cent disease incidence were calculate using the following formula given by (Kokalis – Burelle *et al*., 1992) [8]. The observation on disease score of tikka and rust was recorded 1-9 scale for following method of Subrahmanyam *et al.* (1995) [15] at 15 days prior to harvesting in individual replication in each treatment from randomly selected plant and per cent disease incidence was calculated. Percent disease intensity was calculated for soil borne disease by observing number of infected plant in each treatment and replication from total number of plant.

Results and Discussion

The results presented in Table 1 indicated that collar rot and stem rot incidence during the three year as well as in pooled remain very low. Although, seed treatment with mancozeb was superior in reducing collar rot (1.61%) and all the treatments were superior except control (2.02%; Table 1). Present findings supported the results of Gajera *et al.,* (2011) [4] who reported that *T. viride* and *T. harzianum* reduced the collar rot (*Aspergillus niger*) incidence in groundnut in a pot culture study.

The pooled data revealed that the seeds treatment with Mancozeb as well as foliar application of Hexaconazole were significantly superior in reducing stem rot (0.87%) as compared to the biocontrol agents (Table 1). Seed treatment with mixture of *T. viride* and *P. fl* @ 10 g each / kg + combined furrow application of *T. viride* and *P. fl* @ 2 kg each with FYM @ 250 kg/ha + foliar application of mixture of both @ 2 kg each /ha at 30 and 45 DAS (T_5) was superior (1.39%) in reducing disease as compared to the remaining biocontrol treatments and control (3.39%). Similarly *T. viride* and *Trichoderma* spp. reduced the stem rot disease (Anon., 2012) [2]. In connection to Organic amendment *i.e.* FYM and green manuring applied in soil were reported fungitoxic/fungistatics against soil borne pathogen like *Sclerotium rolfsii* (Stem rot) of groundnut (Johnson *et al.*, 2003) [7]. Application of *T. harzianum* inoculums to soil at the time of sowing was better than other treatments including seed treatment with antagonist in controlling root rot of groundnut caused by *S. rolfsii* (Muthamilan and Jeyarajan, 1996) [13]. *T. viride* along with *Pseudomonas fluorescens* increased the biocontrol activity against stem rot of groundnut caused by *S. rolfsii* (Manjula *et al.,* 2004) [9]. Sclerotial wilt of groundnut caused by *S. rolfsii* was effectively reduced (92.58%) when *T. harzianum* was applied @ 10 g/kg soil (Patibanda *et al.,* 2002) [14].

The pooled data indicated that foliar spray of Hexaconazole @ 1 ml/ lit at 30 and 45 DAS was significantly superior in reducing tikka (19.55%) as compared to the spray of biocontrol agents or neem seed kernel extract (Table 2). But, the application of *Trichoderma* and *Pseudomonas* mixture as seed treatment, furrow application and spray noticed significantly lower tikka disease (38.84%) as compared to control treatment (53.59%).

Likewise, seed treatment with Mancozeb @ 3 g/kg seed + foliar spray of Hexaconazole @ 1 ml/lit at 30 and 45 DAS along with recommended dose of NPK fertilizer was significantly superior in reducing rust disease (24.46%) as compared to the biocontrol agents. The pooled data of three years also revealed that there was significant difference in rust disease between the bio-control agents and control (64.05%: Table 2). Moreover, T_4 seed treatment with *P. fluorescens* @ 10 g/kg seed + furrow application of *P. fluorescens* @ 4 kg enriched with FYM @ 250 kg/ha + foliar application of neem seed kernel extract @ 5 % at 30 and 45 DAS was superior in reducing rust (46.64%) to the remaining biocontrol treatments. This result is in confirmatory with *P. fluorescens* and *T. viride* against tikka and rust (Anon., 2007) [1].

Looking to the yield of groundnut, pod yield was significantly higher in T_7 (1896 kg/ha) where recommended practices *i.e.* seed treatment with mancozeb @ 3 g/kg seed + foliar spray of Hexaconazole @ 1 ml/lit at 30 and 45 DAS along with recommended dose of NPK fertilizer were applied (Table 3). Moreover, all the bio control agent treatments were also significantly superior as compared to the control. While among the three biological control agents, it was found that the highest pod yield (1692 kg/ha) was recorded in T_1, where *Trichoderma viride* was applied as seed treatment (10 g/kg seed), furrow application (4 kg enriched with FYM @ 250 kg/ha) and as spray of *T. viride* (2.5 kg/ha) at 30 and 45 DAS. It was at par with chemical treatment T_7. Perusal of literature indicated by Sharma *et al.,* 2012 that increased significant yield (39.17 Q/ha) and lowest root rot incidence (14.03%).

The highest haulm yield (5484 kg/ha) was recorded in T_7 (seed treatment with mancozeb @ 3 g/kg seed + foliar spray of Hexaconazole @ 1 ml/lit at 30 and 45 DAS along with

recommended dose of NPK fertilizer) where recommended practices were applied and was found significantly superior as compared to the biocontrol treatments (Table 1). While among the three biological control agents, the highest haulm yield (4578 kg/ha) was recorded in the treatment, where *Trichoderma viride* was applied as seed treatment, furrow application and as spray. In the same way, *Trichoderma sp.* controls the pathogen but also improves the overall health of the host (Windham *et al.*, 1986; Ganesan, 2004) [16, 5, 6]. *T. harzianum* controls the pathogens significantly and increases the plant growth. Hence these *T. harzianum* can be used as biocontrol agents for the management of groundnut crop.

Economic

The highest income (Rs. 107256) and ICBR (1:13.52) were obtained in T_7 (Table 2) where Mancozeb was applied as seed treatment and Hexaconazole applied as spray followed by (T_1) *Trichoderma viride* as seed, soil and spray treatment (Rs. 94452; ICBR 1:4.92). It is obvious from the data that fungicides were essential for managing foliar diseases of groundnut. However, those farmers who are interested in organic farming and organic management of diseases can apply FYM (7.5 tonne/ha) in place of NPK and *Trichoderma* spp. as seed treatment @10 g/kg seed and in furrow @ 4.0 kg enriched in 250 kg FYM to realize higher income. But, for the better management of foliar diseases, fungicide Hexaconazole is essential as it reduces the development of inoculum and further spreading of the diseases.

Conclusion

Therefore, based on the efficacy of fungicides, yield and ICBR, it is concluded that seed treatment of Mancozeb, two sprays of Hexaconazole along with the application of recommended fertilizers (12.5N:25P) was very effective and economical in managing groundnut diseases for giving better yield as compared to all the treatments including application of FYM and biological control agents.

Table 1: Effect of organic farming on collar rot, stem rot, tikka, rust, pod and haulm yield of groundnut

Tr. No.	Collar rot (%)	Stem rot (%)	Tikka (%)	Rust (%)	Pod Yield kg/ha	Pooled Mean
T_1	1.52# (2.31)	1.55# (2.40)	38.98* (39.57)	45.99* (51.73)	1692	4578
T_2	1.65 (2.72)	1.51 (2.28)	39.32 (40.15)	45.92 (51.61)	1445	4232
T_3	1.82 (3.31)	1.47 (2.16)	41.70 (44.25)	45.49 (50.86)	1604	4251
T_4	1.58 (2.50)	1.38 (1.90)	40.19 (41.64)	44.22 (46.64)	1501	4098
T_5	1.74 (3.03)	1.18 (1.39)	38.55 (38.84)	44.92 (49.86)	1510	4316
T_6	1.70 (2.89)	1.39 (1.93)	40.62 (42.39)	46.49 (52.60)	1544	4354
T_7	1.27 (1.61)	0.93 (0.87)	26.24 (19.55)	29.64 (24.46)	1896	5484
T_8	1.56 (2.43)	1.47 (2.16)	42.05 (44.86)	48.26 (55.68)	1432	4069
T_9	1.72 (2.96)	1.46 (2.13)	41.44 (43.80)	47.46 (54.29)	1461	4205
T_{10}	2.24 (5.02)	1.99 (3.39)	47.06 (53.59)	53.16 (64.05)	1140	3354
S. Em±	0.16	0.15	1.78	1.27	91	255.0
C D at5%	0.47	0.44	5.29	3.59	271	757.7
C V %	16.09	16.81	7.30	8.41	9.57	11.9
Y- S.Em.±	0.09	0.08	0.98	0.69	50.00	139.7
Y-C.D.at5%	0.26	0.24	2.90	1.97	148.56	NS
YXT-S.Em.±	0.16	0.14	1.67	2.19	84.15	294.2
YXT C.D.5%	0.44	0.39	4.74	NS	238.71	834.6

Numerals in parentheses are retransformed values. # Square root transformation * Arcsin transformation

Table 2: Economics of various treatments

Treatment No.	Pod Yield (kg/ha)	Haulm Yield (kg/ha)	Gross Income (Rs)	Total cost (Rs)	Income increased over control	Net realization	ICBR
T_1	1692	4578	94452	6039	29736	23697	1:4.92
T_2	1445	4232	81953	6039	17237	11198	1:2.85
T_3	1604	4251	89184	5839	24468	18629	1:4.19
T_4	1501	4098	83937	5839	19221	13382	1:3.29
T_5	1510	4316	85214	5959	20498	14539	1:3.44
T_6	1544	4354	86896	5839	22180	16341	1:3.80
T_7	1896	5484	107256	3146	42540	39394	1:13.52
T_8	1432	4069	80716	6039	16000	9961	1:2.65
T_9	1461	4205	82565	5839	17849	12010	1:3.06
T_{10}	1140	3354	64716	4425	-	-	-

Price: Pod= Rs. 45/kg, Haulm=Rs.4/kg, Labour charge for spray = Rs. 225/day, FYM = Rs 0.55/kg

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